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BRIEF NOTE

STRATIGRAPHIC SIGNIFICANCE OF A *DUNKLEOSTEUS* PLATE FROM THE UPPER RICEVILLE SHALE[1]

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Discovery of a *Dunkleosteus* arthrodiran fish plate in dark shale and siltstone (Riceville Shale) beneath the Cussewago Sandstone near Meadville, Crawford Co., Pennsylvania may help to clarify the relationship of Devonian-Mississippian strata in eastern Ohio and western Pennsylvania. Construction of Interstate Route I–79 in 1969 exposed an important stratigraphic section along Van Horne Run, slightly more than one mile southwest of Meadville, Crawford Co., Pennsylvania, on the north side of the highway. The author collected a *Dunkleosteus* arthrodire plate here and was able to measure a stratigraphic section before the road cut was seeded and covered with straw. Construction had exposed a large amount of the shale and siltstone immediately beneath the Cussewago Sandstone. The loose, blasted rock has since been used for road fill, and the cut has been deepened so that the fossiliferous beds immediately below the Cussewago Sandstone are now difficult of access.

MEASURED SECTION

Stratigraphic Unit	Thickness (m)	Thickness (cm)
Orangeville Formation:		
Bartholomew siltstone member:		
7. Fine-grained siltstone with abundant small worm burrows		28
6. Gray, micaceous shale, unfossiliferous	3	50
Berea Sandstone:		
5. Fine-grained, micaceous sandstone with abundant plant fragments	1	22
Hayfield Shale:	(m)	(cm)
4. Interbedded blue gray shale and siltstone, abundant mica and plant fragments, burrow and flute casts; minute worm tubes and *Modiolus* bivalves near base	2	46
Cussewago Sandstone:		
3. Coarse, friable sandstone, thick-bedded, containing shale pebbles	1	2
Upper Riceville Shale:		
2. Thin-bedded siltstones and interbedded dark gray to black shale containing an abundant "Knapp" marine fauna with Mississippian aspects (*Syringothyris, Sphenotus aeolus*) as well as sponges and and worn *Dunkleosteus* plate	4	4
Lower Riceville Shale:		
1. Thin-bedded siltstone with minor amounts of olive-brown shale; marine fossils common, replaced by iron oxide; fauna (*Cyrtospirifer, Reticularia*) identical with that of uppermost Chagrin Formation of Ohio	3	5

This stratigraphic section was compared with the well known Bartholomew section west of Little's Corners, Hayfield Township (White 1881, de Witt 1951, pl. 2) and with the Riceville section (White 1881, Caster 1934) 0.6 mile southwest of Riceville, Athens Twp. The former location is the type locality for the Hayfield Shale and the Bartholomew siltstone member of the Orangeville Shale. In considering the Meadville section, it should be noted that the terms "Upper Riceville" and "Lower Riceville" are not as yet formally defined rock-stratigraphic

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units but informally defined divisions of the Riceville Shale based upon paleontological criteria.

Lateral and anterior views of the *Dunkleosteus* plate are shown in figure 1.

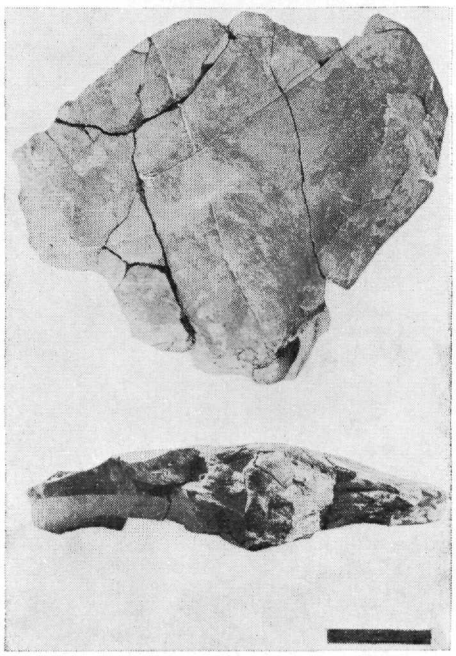

FIGURE 1. Lateral and anterior views of the *Dunkleosteus intermedius* plate. (OSU–29724). Maximum dimensions measured parallel to the anterolateral sensory canal 18.9 cm and at right angles to it 23.1 cm. Bar scale equals 5.0 cm.

Though fractured by blasting, the specimen is a nearly complete left anterodorsal plate. A fragment about 5 cm^2 is missing from the dorsal margin and several smaller fragments are missing from other portions of the plate margin. Maximum dimensions measured parallel to the anterolateral sensory canal and at right angles to it are 18.9 and 23.1 cm respectively and maximum thickness is 2.0 cm. The mesial ridge which supports the anterior condyle is 4.6 cm high. William J. Hlavin (formerly of Cleveland Museum of Natural History) has noted that the plate exhibits considerable wear along the anterior and dorsal margins, but it is unlikely that the plate is actually reworked or that it could have been transported very far. This opinion is based on the size of the plate, its completeness, and the relative lack of wear compared to definitely reworked *Dunkleosteus* specimens from the Cleveland and Bedford formations of Ohio. Specific identification of the plate remains uncertain, but the moderate size and rounded outline indicates *D. intermedius* rather than *D. terrelli* or *D. curtus*. The specimen has been deposited at Orton Museum, Ohio State University (OSU–29724).

The occurrence of a large *Dunkleosteus* plate immediately beneath the Cussewago Sandstone at Meadville has considerable stratigraphic significance, particularly when the lithology of the enclosing sediment is considered. The specimen was found in place, in a thin, light gray siltstone interbedded with dark gray, almost black, micaceous shale. Marine invertebrates occur in the siltstone but were not observed in the dark shale. Bioturbation had mixed the black shale and light colored siltstone in places.

The dark shale of the stratigraphic unit in which the specimen was found is believed to represent an eastern extension of the uppermost Cleveland Shale of Ohio (Szmuc, 1970). Such an interpretation is greatly strengthened by the occurrence of *Dunkleosteus*. In eastern Ohio *Dunkleosteus* is restricted to the Cleveland Shale, though small reworked fragments occur in the basal Bedford Formation west of Cleveland. The present discovery strongly indicates that the easternmost extension of black shale deposition in latest Cleveland times occurred in the Meadville area and that the uppermost Cleveland Shale or the Cleveland-Bedford transition zone is contemporaneous with strata included in Caster's Knapp faunal zone (the upper part of de Witt's Riceville Shale).

Caster (1934) suggested that the Marvin Creek Limestone and the genetically related Kushequa Shale, both members of his Knapp monothem, contain earliest Mississippian faunas. This opinion was confirmed by more recent work (Holland 1958, Sass 1960) on the Knapp invertebrates. The Kushequa Shale (the lower part of the Knapp beds) is not found west of Warren Co., Pennsylvania, but the upper (Marvin Creek beds or equivalent) strata do continue westward as far as

Riceville and Meadville, where they have been included in the Riceville Shale by White (1881), de Witt (1951), and Pepper *et al* (1954). Caster's recognition of these Knapp-equivalent beds in the Meadville area has been confirmed by my recent field work and the discovery of the Knapp *Syringothyris* zone at the arthrodire locality as well as at the Taylor Strand School section one mile west of Taylor Strand School, Athens Twp., where it occurs in the basal Cussewago Sandstone. The Knapp faunal zone is also present below the Cussewago Sandstone at de Witt's (1951, pl. 2) locality L, 0.8 mile south-southwest of Beech School, Woodcock Twp., where several complete echinoids (*Hyattechinus pentagonus* Jackson) and *Syringothyris* have been found. At all points examined west of French Creek, I found the base of the Cussewago Sandstone is either covered or lies unconformably upon fossiliferous siltstone of the Upper Devonian Chagrin Formation. The base of the Cussewago Sandstone has not been observed in Ohio (Szmuc 1970; Rau 1969). Erosion antecedent to deposition of the deltaic Cussewago Sandstone apparently removed the Upper Riceville and Cleveland Shales in the area northwest of Meadville.

The existing paleontologic and stratigraphic evidence indicates that the Cussewago Sandstone is a deltaic facies essentially contemporaneous with the prodelta marine Upper Riceville or Knapp shale and siltstone facies. The uppermost Cleveland Shale can be considered a black shale facies deposited further offshore from the stratigraphically higher Cussewago delta sands and can be correlated with the Upper Riceville prodelta shale on the basis of the *Dunkleosteus* occurrence at Meadville. The depositional relationship of the Cussewago Sandstone, the Upper Riceville, and the Lower Riceville shales is precisely analogous to that of the deltaic Bedford/Berea, prodelta lower Bedford/Cleveland transition zone, and the Chagrin Formation of Ohio, although the Cussewago deltaic sequence was deposited slightly earlier and over a smaller geographic area.

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